THURSDAY, OCTOBER 5, 1882

FLUIDS

Experimental Researches into the Properties and Motions of Fluids with Theoretical Deductions therefrom. By W. F. Stanley. (London: E. and F. N. Spon, 1882.)

THE aim and general scope of this work is well described in its modest and explicit preface. It is essentially a tentative and qualitative treatise, the author expressing a wish in his preface that some highly educated mathematician who may care to follow him, will clothe with his skill the rude, but as he believes, natural underlying forms he has brought in some cases to light. Modesty such as this, undoubtedly tends to disarm criticism, but after a careful perusal of the work, we cannot help cherishing a sincere regret that the author does not himself happen to be the much desired mathematician. We feel certain that if this had been the case, many mistakes would have been avoided, much speculation curtailed, and the value of the work considerably enhanced. Thus while the author admits that "the eighth chapter is very incomplete on certain points for want of sufficient research into the works of others and more experiment," we find the work characterised throughout by a lack of the same knowledge of what is already known, or has been done by others.

Too often also the deductions appear to have been preconceived, and the experiments from which they are supposed to follow are either too rough, or of too special a nature.

As the author speaks disparagingly of his own educational acquirements, it would be unfair perhaps to criticise too harshly a literary style, which certainly detracts very much from the pleasure or comfort of studying his work. He might, however, have tried to be a little more clear, and somewhat less pedantic in the construction of his sentences. Almost every idea has to be disinterred from a heap of polysyllabic adjectives and adverbs, which most effectually obscure its meaning, while very often we meet with paragraphs of, at any rate at first sight, a most incomprehensible character. Such as the following:—"Such *equilibrium* acts as a *condensation* upon the surface of a liquid, thereby increasing the molecular surface density," or "the *area* of efflux of the liquid will be the mean of the directive *impulses* of vertical and horizontal pressures." Elsewhere he speaks of "a narrow *vacuous* plane" and "*motive* quiescence."

On the other hand there is much that is novel and worth perusal in the book, more especially in Chapters IV., V., VI., and VII., and in Section III. on waves.

One very prominent fault which we notice all through the work, is the almost entire absence of any distinction between the physical properties of compressible and incompressible fluids. The words fluid and liquid are used quite indifferently, and whatever principles the author deduces for water, are immediately and without trial assumed to be true for air and gases, and *vice versâ*. Again, the experiments which are mostly of a very simple and rudimentary character, are not sufficiently differential. Thus in experiments on liquids, water alone is employed, and in like manner air is the sole representative of the gaseous state, though in a work dealing with fluids generally, one might have expected to hear *something* at least of the properties of *all* the more easily procurable gases and liquids.

The first three chapters deal with the theory of the constitution and motive properties of fluids, and are, as the author admits in his preface, "speculative and even in parts hypothetical." In opposition to Clerk Maxwell and others, he holds that "Fluids are composed of *static* atoms, infinitely tough and elastic, their fluidity depending on the presence of gases or liquid vapours held by attractive forces upon the molecular surface and intruded intermolecularly, the surrounding envelope of gas acting as a lubricant to the motions of the molecule composing the liquid proper."

This system of gaseous atmospheres surrounding the molecules is supposed to extend to all matter, and expansions by heat forces to vary as the powers of evaporation of the separate molecules. From this point of view the author attacks the theory which has been considered to satisfactorily explain the phenomena observed by Mr. Crookes in high vacua. He maintains that such phenomena are not due to the projection of the molecules of the residual gas, but to convection currents of gas formed of metallic matter composing the negative pole. He does not, however, attempt to give any adequate explanation of several of the accompanying appearances observed, such as molecular shadows, and phosphorescence, the circumstances attending which, so strongly favour the theory of the rectilinear propagation of the free molecules of residual gas, which depends, as Mr. Tolver Preston has lately suggested, on "the relative dimensions of the containing vessel to the mean path of the molecules," and are so completely inexplicable by the physical properties of any ordinary convection current.

In his preface, the author says he ventures to differ from the generally accepted theory of tensile surfaces for liquids, and prefers to consider them extensile. In Chap. II. he thus defines these words:—

> "By tensile I intend a disposition of the parts of a system of matter to draw themselves together as a stretched drumskin does. By extensile I intend the reverse of this, or the disposition of the parts of a system of matter to separate, and thereby to engender external pressures."

He then proceeds to show how, according to his theory of the constitution of liquids, the surface (except in the case of free films) has a tendency to extend by virtue of surface condensation arising from the cohesive force between the superficial molecules.

We fail, however, to see how this assumed surface condensation gives rise to extensibility, since no force other than a strictly lateral one can act at the surface of a liquid without being equally felt all through it, while it would obviously be arguing in a circle to say that *lateral* attraction of superficial molecules produced *lateral* extension of the surface.

Moreover the author assumes that a tensile surface is one which is so stretched already, that it would give way under any additional pressure, while extensile is used to mean not so much disposition to extend, as capability of stretching.

Thus the familiar experiment of the needle floating on ater, would the author thinks, be impossible were the surface tensile. Doubtless, according to the author's definition of tensile, it would be so, but we think it would be equally impossible unless the surface were endowed with a tolerably high tension, such as water is known to possess.

We find it impossible also to accept the author's explanation of the various capillary phenomena on the same hypothesis. To take the case of capillary elevation and depression alone. If the surface force on a liquid is extensile, it can be easily shown by reversing the reasoning given in the ordinary physical text-books, that in the case of capillary elevation, the free surface would be convex, and in the case of capillary depression, concave, conditions, precisely the opposite of those which actually take place. The same hypothesis is equally unsuccessful when applied to the resolution of jets into drops. Mr. Stanley considers drops to be formed when the mass cohesion of a jet is equal to the extensibility of its surface, and in order to show that this is the principal cause, he falls into the serious error of imagining that a jet of liquid (water is the only one mentioned) issuing from a small orifice, *continually* expands in sectional area beyond the vena contracta, whether the stream be directed *upwards* or *downwards*, the final resolution into drops being due to such expansion caused by extensibility. We know, however, that this cannot be the case, since although the jet expands slightly beyond the vena contracta, in accordance with the equation of continuity it again *contracts* if flowing downwards, and the reverse if flowing upwards, and since in either case, whether in waterfalls or fountains, the jet ultimately becomes converted into spray, the author's explanation is obviously erroneous. It is to be regretted for many reasons that in dealing with this interesting though difficult subject of surface tension and capillarity of liquids Mr. Stanley makes no mention of the researches of Van der Mensbrugghe, Tomlinson, Duclaux, or of the very remarkable results obtained not long ago by Cintolesi, and that while the names of Young and Laplace are mentioned once, not the smallest account is given of their researches

Chapter III. chiefly relates to the conditions of the efflux of liquids through orifices. A great deal of it is almost unintelligible from the obscurity of the language employed, and the loose way in which the expressions, energy, weight, velocity, force, and volume are employed as though they were identical.

As far as it is possible to glean anything definite from such a chaos, it would seem that the author thinks the known contraction which takes place in the area of efflux of a liquid through a vent, is due to horizontal elastic compressions caused by the reaction of the vessel against the pressure of the liquid it contains. No reference is made to the Torricellian equation, which according to the author's notation should take the form $v^2 = 4gh$; instead of $2gh$ as ordinarily; or to the theoretical results got with different forms of orifices on the parallel section hypothesis. We do not think the author has got on the right tack here. The horizontal velocities which must necessarily arise, either from the natural or artificial narrowing of the descending column, and which are disregarded by the parallel section hypothesis, may be readily conceived to act so as to contract the area of vertically descending liquid, and not elastic compressions, which have little place in the dynamics of a practically incompressible liquid.

In Chapter IV. the author tries to show that the general relative motion of fluids on solid surfaces or in other fluids is effected by means of rolling contact. The hypothetical case of a plane supported on equal rollers, and moving on a parallel plane is taken, and the analogy to this pointed out in different cases, such as where a river moving relatively to its bank causes small lateral eddies, or where larger rotatory movements are produced in the bays or widenings through which it flows. Several instances apparently exhibiting this kind of motion are noticed, but we cannot agree with the author that such examples conclusively prove his theory, and that no sliding takes place. The internal molecular friction or viscosity of most liquids, must necessarily cause rolling contact, if it occurs at all, to take place in a very imperfect manner, and at the same time admit of sliding with a certain amount of friction.

In Chapter V., which treats of the resistance of fluids to the projection of fluids or solids within them, Mr. Stanley develops some novel nomenclature, and a principle of considerable importance which may be briefly enunciated as follows :—When a mass of matter strikes a fluid such as water, it fractures a conical part immediately in front of it, called the cone of impression, from the surrounding mass called the conoid of persistion, and intrudes itself into the fracture, which is called the plane or cone of infraction. This principle, which is frequently appealed to in subsequent portions of the work as one of fundamental importance, and on which a host of minor propositions depend, is derived from an analogous principle of conic fracture in the case of solids, and is supported in the case of liquids and gases by various experiments, such as the shape assumed by a leaden bullet shot vertically into water, the ring formed by a drop of coloured dropped into uncoloured water, and the phenomena of smoke-rings as shown by Prof. Tait. The experiments are clear, and the idea is skilfully and consistently worked out as far as it goes.

Whether all the properties of vortex-rings will be found to accord with this principle, is a question which may be safely left to those who make such matters their special study, but at all events the explanation given of the smoke rings, and the experiments showing the absence of a motive axis, are decidedly ingenious.

From the foregoing principles the author proceeds to deduce in Chapter VI. the conditions for the *continuous* motion or projection of fluids within fluids, in which rolling contact again comes into play, through the final rotation of the conoid of persistion, and the formation of whirl and biwhirl systems. Several interesting experimental examples of such systems are described and figured, and some of the laws which apparently regulate such systems are proposed, though the proofs appear to rest solely upon a somewhat limited ocular experience.

Towards the end of this chapter is introduced the well-known paradoxical fact first noticed by Clement Désormes and Hachette in 1826, that a blast of air or stream of water flowing in their respective fluids, apparently attract towards themselves flat bodies placed directly in their paths, and an endeavour is made to account for it in a not very obvious manner, by means of certain backward forces arising from induced whirl-systems. Whether some small portion of the phenomenon may not be due to an induced reflex action, is a point worthy of investigation, but the major portion is generally admitted to be due to a principle with which, the author, since he entirely omits all reference to it, is apparently unfamiliar, viz. that the pressure both of compressible and incompressible fluids is diminished by an increase of velocity. A conclusion drawn by the author from an experiment on p. 276 is similarly invalidated by the omission of the same principle.

The way in which fluid moves in pipes or channels is described in Chapter VII., and is concluded to be by rolling contact on a continuous system of lateral whirl-rings, "these being alternately collected by reflex action, that converts these whirls into loops, which permit the deflected fluid to re-enter (in a hypercycloidal curve) the central system by traction."

The same principle of rolling contact and the development of whirl-systems is, in Chapter VIII., applied to the motions of solids through fluids, more particularly of ships, through water. The eddies, for example, which we ordinarily observe at the rear of boats are regarded by Mr. Stanley, not as resulting from the meeting of two relatively opposed currents, but as friction rollers engendered by the passage of the body through the liquid. The general effects of rudders on the motion of ships, and the peculiar cases noticed by Prof. Osborne Reynolds and others, are ascribed to the position and influence of such whirls, and not to the mere deflection of stream lines. Although a good deal of what the author says on this point is, as he admits himself in the preface, very speculative, and though the theoretical action from which it all proceeds is not very plain, there is much that is suggestive and worthy of study.

Section II. is devoted to a consideration of Oceanic and Aërial Systems of Circulation, which are assumed to be gigantic whirl systems arising from the projection of water within quiescent water, or against solid areas of resistance such as capes and promontories. A good deal of the matter usually found in treatises on physical geography is here reproduced, as to the general forces in action to disturb equilibrium, but in the case of general oceanic circulation, too much importance is, we think, attached to the thermal causes of circulation discussed by Lenz and Dr. Carpenter, and too little notice taken of the effect of prevailing winds in causing at least superficial ocean currents. Nothing very fresh is adduced in explanation of the causes of the currents as they are at present known. The main currents, such as the Atlantic equatorial, are assumed to exist, and all the author does, is to try and arrange them as large circles or whirls to suit his whirl theory, and which please the eye just in proportion as they diverge from the truth and irregularity of nature.

We do not doubt that the currents occasionally take the form of whirls such as those exhibited by the author, since their deflection by continents and the continuity of the circulation, requires the water to flow more or less in closed curves, but we cannot agree with the author's view that the Southern Polar drift current is simply a huge whirl, set spinning round by the tangential forces exerted by the whirl systems of the South Atlantic and South Pacific. We prefer the simpler and more rational view that it is a result of the constant and similarly directed wind system of that region. Another view indulged in by Mr. Stanley on p. 377 that the southward pointing of the continents is due to action of ocean currents acting through countless ages, is not more probable than the astronomical hypothesis that this is due to a northward motion of the earth in space. Besides, the abyssal character of marine basins shown by Sir Wyville Thomson, forms a positive objection to any such notion.

The author's views of atmospheric circulation are not happy. For example, in his chart of the general system of air motion, which he tries to reduce to two large "ellipsoidal whirls" having their southern foci in June, near the east of the United States and China respectively, and which correspond roughly to the general motions traceable over the sea areas, we find the motion of the air over the western part of North America and the Indian peninsula distinctly contrary to what is known to occur at this season from observation.

It would indeed be a tedious task to point out all the questionable hypotheses or erroneous conclusions with which this part of the work teems. One or two, however, we cannot overlook. For example, the absurd idea that the prevailing south-west winds over the flat plains of Northern Europe, are an indraught to feed the cold and therefore contractile area of Central Europe and Asia. The author travels in vain all round Asia, in search of a current to satisfy the cravings of this contractile area; and this is the only one which has an approach to the necessary direction. We need hardly say that we are totally unable to credit our south-west winds with the ability to perform such a feat. Areas of cold air, are areas of contraction in a *vertical*, not *horizontal*, direction, and are fed by *upper*, not *lower* currents.

In another place we are told that directly under the sun in the tropical region there should be no cloud, owing to the vapour remaining *uncondensed under vertical solar rays*. At about 30° N. and S., however, there should be bands of cloud and constant precipitation. Now, as a matter of fact we know that the actual conditions are precisely the reverse of these. Thus in the tropics, whenever the sun becomes vertical over any region, he is invariably accompanied sooner or later by a band of cloud and consequent rainfall, while the areas 30° N. and S. are notably those of small precipitation and almost constant sunshine.

Again, we cannot agree with the statement on p. 444 that "all cloud systems by their superior weight will be descending," or that "condensation of vapour causes a descending area." The very continuity of the existence of a cloud is dependent on its forming part of an *ascending* area, since by well-known physical principles, if such an area once began to descend, the cloud would, *cæteris paribus*, almost immediately be re-absorbed and become invisible.

Another conclusion of the author's is in striking opposition to the doctrine ordinarily held by meteorologists; viz. that the cyclonic area is one of ascent, and the anti-cyclonic one of descent. Mr. Stanley says: "Upon the principle of whirl motions they would be the reverse of this," but we entirely fail to see how or why.

Altogether we are not favourably impressed with this part of the work, and do not deem it likely to accomplish the author's forecast in his preface, viz. "aid in the elevation of the sciences of physical geography and meteorology, now sciences of *observation*, to sciences of *principle*."

The last part of the work, treating of aqueous surface-waves, which we have not space to notice in detail, is a considerable improvement on the foregoing chapters. We are surprised, however, to see that while some notice is taken of the researches of M. Flaugergues and Mr. J. Scott Russell, no reference is made to those of the late Mr. Froude.

In conclusion, the type and illustrations are decidedly good, and though we cannot describe it otherwise than as a preliminary investigation into certain portions of the dynamics of certain fluids, accompanied by a good deal of speculation and deduction which still requires verification, and which is sometimes palpably erroneous, it nevertheless represents a very laudable, and to some extent successful endeavour on the part of the author to fill up a gap that admittedly exists in this abstruse branch of science. E. D. A.

HANDBOOK OF INVERTEBRATE ZOOLOGY

Handbook of Invertebrate Zoology for Laboratories and Sea-side Work. By W. K. Brooks, Ph.D. (Boston, 1882.)

THE series of notes and directions issued under this title by Mr. Brooks, of the Johns Hopkins University, Baltimore, is an interesting evidence of the progress which the practical study of zoology is making in American universities, and more especially of the valuable services which the Baltimore University is rendering to education in science. The book consists of brief notes describing the appearances of a series of invertebrate animals before and during successive stages of dissection or development, as the case may be. Diagrammatic sketches (for the most part original, or copied with a few original touches from English authors) are introduced into the text. The animals chosen by Mr. Brooks are the following:—Amœba, Paramecium, Vorticella, Sycandra (Calcispongiæ), Eucope (Leptomedusæ), Mnemopsis (Anthomedusæ), Asteracanthion, Arbacia (Echinid), Lumbricus, Macrobdella (Hirudinean), Callinectes (Brachyurous Decapod Crustacean), Cyclops, Acridium (Orthoptera), Anodonta, Loligo.

Concerning each of these forms the reader will find original remarks and often detailed observations illustrated by sketches. At the same time the writer does not pretend to offer us a series of monographs, but merely such notes as will be eminently serviceable to students in the laboratory. It is no doubt to American students and especially to Mr. Brooks's own pupils that this work will be useful. Such descriptions as that of the development of Arbacia, and those relating to the Medusæ, have their value immensely increased when it is possible to place in the hands of the student the identical material—or perhaps we should say the counterpart of that material—which has served for the preparation of the descriptions which are to guide the student's observation.

Though class-students in this country will not gain much assistance from Mr. Brooks's notes, professed zoologists will be interested in his treatment of the subject, and may glance with advantage at the more detailed sections, such as that on the Lamellibranch gill, on the anatomy of the Squid, and on the Medusæ.

If we ventured on a criticism, it would be to suggest a doubt as to whether the types selected and the relative importance given to their treatment are altogether such as would commend themselves to a teacher who aimed at introducing students to a wide view of animal morphology. Naturally enough, Mr. Brooks has given notes and drawings relating to several animals which he has been able to study attentively. It is, however, hardly wise on his part to repeat in a student's handbook the account of the development of the oyster which he has already published elsewhere. This account, which was inconsistent with the previous results of other investigators of molluscan embryology (my own included) has been recently shown by Horst to be based upon error. So, too, it would be well if in a new edition of his notes Mr. Brooks were to take into account the later results which have been obtained as to the anatomy of the earth-worm and of leeches, and would revise both his drawings and statements in various sections of the book, where they touch upon distinctly histological matters.

The day is not far distant when we shall see inscribed over the door of every zoological laboratory, "Let no one enter here unversed in histology." Geometry was not less indispensable for the intelligent student of Greek science than histology is rapidly becoming for the modern zoological student. The question is how to find time (except in countries where time is *not* money) to make the student first a histologist, and then a zoologist.

E. RAY LANKESTER

OUR BOOK SHELF

Cameos from the Silver-land; or, The Experiences of a Young Naturalist in the Argentine Republic. By E. W. White. 2 vols. Vol. II. (London: J. Van Voorst, 1882.)

THIS second volume has been slow to make its appearance, having been printed at Buenos Ayres. It gives an account of the author's voyage up the Uruguay, his trip to Rioja, Catamarca, and Tucuman, a journey to Salta, and a voyage down the Paraná. There is a good deal of interesting information in this volume, though it contains very much less natural history than we expected. The wonderful resources of the Republic are well brought before us, resources only too feebly made use of; for it is a land of promise teeming with treasures, with a splendid river porterage, and needing only labour and capital to become very great. To a reader wishing to know the actual state of things at present existing in this country we can recommend these two volumes of Mr. White's as most instructive reading.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Aurora

LAST night, between 8 and 9 p.m., there was visible here a very fine display of Northern lights, the finest indeed that I